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HEREDITARY INFLUENCE ON VERTICAL FIBER STRUCTURE AND STRENGTH VARIATION IN SIDE UPPER LEATHER*

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ABSTRACT

The prevalence of the vertical fiber defect in Hereford hides suggests some degree of genetic control as a predisposing factor in its cause. Cooperative evaluation of 130 hides from the steer progeny of 15 registered bulls was undertaken to obtain supporting evidence for this hypothesis. Data derived from a variety of physical tests for leather strength were analyzed to arrive at a classification into four degrees of strength. Distribution plots of each property indicated five useful parameters for this purpose. Analytical data and degrees of strength showed some interesting correlations with fiber structure as determined from close-up photographs of leather strips.

The incidence of weakness was plotted for the offspring of each of the sires, whose families ranged from four to 14 members. Half of the sires produced families showing 35 percent or more of weak hides. The offspring of some sires had moderate numbers of definitely defective hides, while other families showed no weakness. Although the results suggest that the defect is heritable, the small numbers of available offspring limit the degree of confidence in this conclusion.

INTRODUCTION

Weakness in side upper leather has always been a serious problem to the producer as well as to the consumer of this type of leather. Sometimes it can be traced to improper treatment of the hides, either before or after they reach the tanner, and this can be corrected. Far more serious is the extreme weakness, inherent in certain hides, that is due to abnormal fiber structure, for which there is no known cure or prevention. This condition has come to be known as "pulpy butt" and is found most often in heavy Hereford hides. Following the

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original discovery of the defect by Amos (1) in Australia, it has been well re-established by Tancous *et al.* (2–4), Everett *et al.* (5), and Maeser (6) that the weakness is caused by the vertical fiber defect, wherein most of the corium fibers are nearly perpendicular to the grain surface and are not well interwoven.

It has been stated that the defect tends to be localized in the kidney area of the bend (2). This is a rather ambiguous term that actually refers to a fairly large area. The study by Maeser (6) and observations in this laboratory indicate that almost the entire butt region is commonly affected, as well as a broad zone along the backbone. It is thus apparent that typically affected sides are seriously weakened over much of their area and are unsuitable for many uses.

A wide variety of physical tests have been devised to measure leather strength, based on the requirements of the intended end products. Correlation between various test methods for determining both strength and elongation of leather specimens has been reviewed and reinvestigated (7). Grain crack during lasting is one of the most frequent reasons for failure, since the bulk of production is used in shoes. Therefore, it is felt that some variant of the ball-burst test should be more universally applied in leather evaluations, as indicated by a study of lastability (8), along with a tensile test where strength in one direction is important.

Maeser (6) illustrated the usefulness of a close-up photograph of the edge of a leather cut for evaluating fiber structure. This obviates the need for tedious preparation of photomicrographs from microtome sections. Defective and normal extremes can readily be differentiated and an intermediate form usually associated with weakness can also be recognized with some experience. Variations in depth of dye penetration reflect the extent of the structural looseness or porosity; fatliquor penetration is likewise known to be much deeper in leather with vertical fiber (1, 5). Analytical values for some common components should be helpful in confirming the extent of this correlation.

This study was intended to produce evidence as to whether the vertical fiber defect might be inherited, or show signs of genetic control by being more concentrated in a few family lines rather than being randomly dispersed. It was first necessary to procure suitable hides from animals of known parentage and have them processed into leather. Then came the problem of devising a system for accurately classifying them into various levels of strength — a difficult and controversial area. A new approach to this problem is presented herein. Finally, the incidence of weakness was plotted for each group of offspring to indicate genetic influence.

EXPERIMENTAL

Hide Source.—After investigation of several different possibilities, a fortunate series of co-operative agreements was successful in obtaining 137 hides from steers of known Hereford origin. The animals had been raised in Wyoming but were fed and slaughtered in Iowa. Further details are listed in the acknowledgments. Identities were ascertained from ear tags and the same numbers were stamped into the hides. For various reasons, seven hides were not suitable for final evaluation, leaving a total of 130 for this study.

Leather.—The experimental hides were processed into tropical combat boot leather by a co-operating tanner, stopping at the unfinished crust stage. Ball-burst tests were performed on both sides in the tannery laboratory, and tensile specimens were supplied to this laboratory from one side of each hide. Some of the sides were not recovered.

Ball-Burst Test.—The one-inch ball-burst tests (6) were made on specimens cut from a standard location in the upper portion of the butt, about 12 inches from the backbone and eight inches from the tail. The measurements recorded were thickness, load and distortion to grain crack, and load and distortion to burst. Values from left and right sides were averaged to provide one figure to represent the hide. A "lasting factor" similar to one recently proposed by Maeser (8) was calculated as follows:

$$\frac{\text{Grain Load} + \text{Burst Load}}{\text{Thickness}} \times \frac{\text{Grain Distortion}}{\text{Burst Distortion}} = \text{Lasting Factor}$$

Loads were expressed in pounds; thickness and distortions in inches.

Tensile Test.—Tensile specimens were cut from areas adjacent to the ball-burst specimens, one parallel to the backbone and one perpendicular, from left sides only. Standard tests were performed on the Instron in our Physical Chemistry Laboratory. Load and extension to crack, and load and extension to break, were read from the stress-strain tracings.

Photograph of Leather Cuts.—Narrow strips of leather were cut with a razor blade from each end of the two tensile specimens. The four replicate strips were placed on edge on a horizontal glass plate supported by clamps from a metal framework. A 35 mm. camera with close-up lens was likewise supported beneath the plate so that it could be focused on the upper surface of the plate. This procedure facilitated the arrangement of all four specimens in the same focal plane. Illumination came from below at a low angle to produce a shadowing effect and thus enhance the three-dimensional interpretation of the cut fiber bundles. By using color film in the camera, slides were obtained which were projected on a screen to provide ample magnification for evaluating the structure. This also illustrated the depth of dye penetration which, along with angle of weave and compactness, served as an additional index for grading the abnormality of the structure. The grade was expressed as the average percent (to the nearest ten) of the corium considered to be abnormal in terms of looseness and porosity.

Leather Analyses.—Tensile specimens from six different sides in each of the four strength grades, after testing, were ground in a Wiley mill for analysis. Moisture was determined on samples of approximately three grams, and the residues were used to determine ash content in the usual manner (ALCA Method B-15). Aliquots of pooled samples of the ash residues were treated with hydrofluoric acid, and again ignited to constant weight, to determine silica (SiO_2). Fat (lipids) was determined on three-gram samples by extraction with chloroform (ALCA Method B-4). Extracted residues were further extracted with anhydrous ether, and extract weights were added to those from chloroform. Fat extracts were tested for nonlipid components by igniting to constant weight. Inorganic residues ranged from two to four percent of lipids, indicating a negligible amount of contaminants. Chromium (Cr_2O_3) was determined by a recently developed atomic absorption method (9, 10) on samples of approximately 0.1 gram that were hydrolyzed by refluxing in 2 N HCl. This procedure affords a considerable saving of time and results compare favorably with the usual method (ALCA Method D-10).

RESULTS AND DISCUSSION

Distribution Curves from Strength Tests

Ball-Burst Test.—In order to distinguish between several categories of strength within the large population of hides under study, it was considered that distribution plots would be helpful. For the ball-burst test, for example, plotting the number of hides of each value on one axis against increments of bursting force on the other axis, tells how uniformly this property is distributed among the experimental hides. Figure 1 shows this plot on the solid line. Obviously this curve does not show the typical bell shape of normal distribution. The main central peak includes most of the hides, which makes this the normal group. The secondary peak at the left includes all the weakest hides, which we consider defective. The narrow, overlapping region at their junction is an uncertain "gray area" of weakness which probably includes both normal and defective hides. The shoulder on the far right includes all the strongest hides and occurs repeatedly as a separate category. In this manner we can distinguish four different arbitrary grades of strength by this test, as indicated by the grade scale at the bottom of the figure. Grade 1 includes the defective hides; Grade 2 includes the intermediate or weak group, not necessarily defective; Grade 3 is the normally strong group; Grade 4 includes the unusually strong hides. The dotted curve in Figure 1 shows the plot for the force to crack the grain. Since there is only a single peak, this curve is not useful for our purpose.

In addition to using the values for force, we also calculated the work involved in the ball burst, that is, the product of the load and distortion. In Figure 2 the distribution curve for work to burst (broken line) shows only a single peak and is therefore not useful. However, the lasting factor, which is a combined work

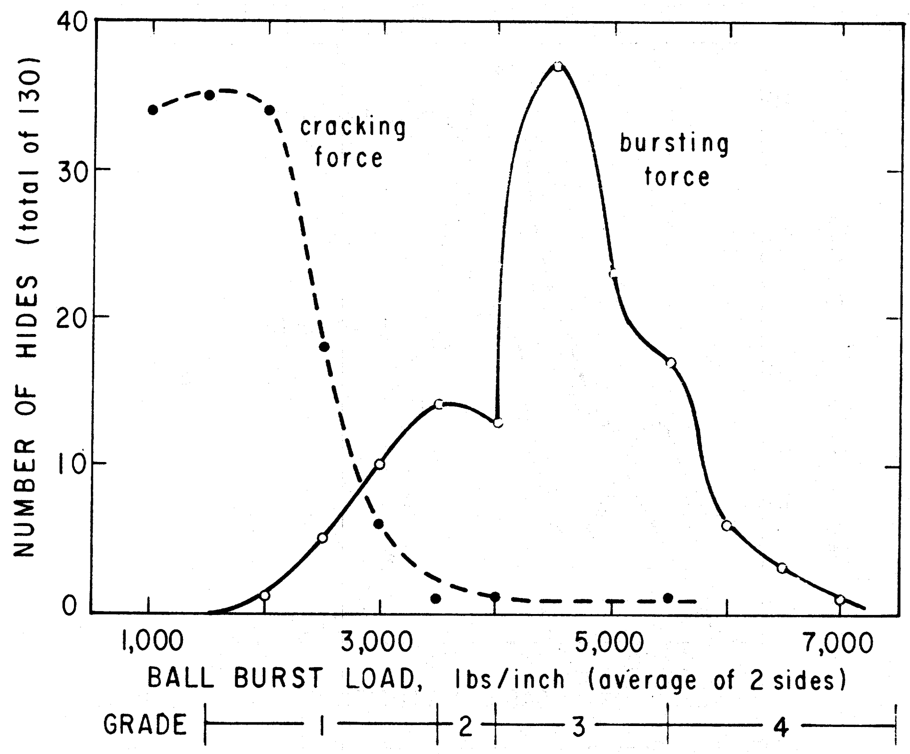

FIGURE 1.—Distribution of one-inch ball-burst load values from 130 Hereford hides. The curve for bursting force distinguishes three separate components and a junctional region, as indicated by the grade scale at the bottom. Cracking force gives only a single peak.

term weighted in favor of distortion to grain crack, displays a very useful distribution curve (solid line). There is good discrimination between each of the three main grades of strength. A similar plot of the distribution of work expended to crack the grain, not shown here, gave a third useful curve, although it was not as distinctive as the preceding ones. Curves for distortion alone were not useful for characterizing the hides.

Tensile Test.—Next we evaluated the strength values obtained from the tensile test. Figure 3 shows typical tracings from samples of the two grades of weak leathers. It can be seen that the Grade 1 or "pulpy" leather on the left cracked early and often, especially in the parallel direction, as indicated by the jagged shape of the tracing. The same relationship, to a lesser degree, is apparent for the Grade 2 leather on the right. The perpendicular specimens usually had a higher value for PSI to break. Figure 4 shows similar tracings for the two grades of strong leathers. Note that the parallel specimen on the left showed some tendency to crack while the perpendicular piece did not, nor did either of the specimens on the right. Note also that the vertical scale is doubled on the right,

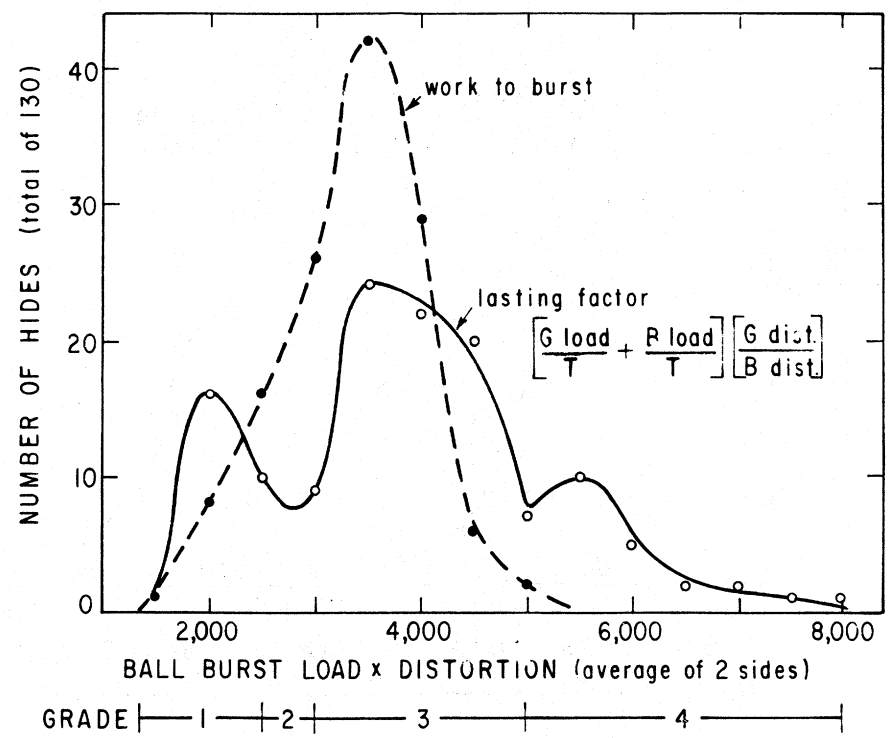

FIGURE 2.—Distribution of work values derived from ball-burst test. The curve for lasting factor, calculated as shown, gives good discrimination as defined for Figure 1. Values for work to burst (load x distortion) show only a single peak.

and again the perpendicular pieces were stronger. It is realized that cracking during a tensile test is not usually utilized for leather evaluation, but we found it to be a useful property.

Figure 5 shows a distribution plot of the force to break in the tensile test. It can readily be seen that values from the perpendicular pieces (solid line) displayed another very useful curve, with three distinct peaks, while the plot for the parallel pieces (broken line) showed only a slight shoulder to the main peak and was not useful. Conversely, the plots of the tensile load to crack, not shown here, gave a useful curve for the parallel direction only. Plots of values for work or extension from the tensile tests were not sufficiently discriminating to be useful for characterization.

Hide Classification by Strength.—To summarize the results of this approach to strength classification, five useful distribution curves were obtained by plotting, from the ball-burst test, (1) force to burst, (2) lasting factor, and (3) work to crack, and, from the tensile test, (4) force to break, perpendicular, and (5) force to crack, parallel.

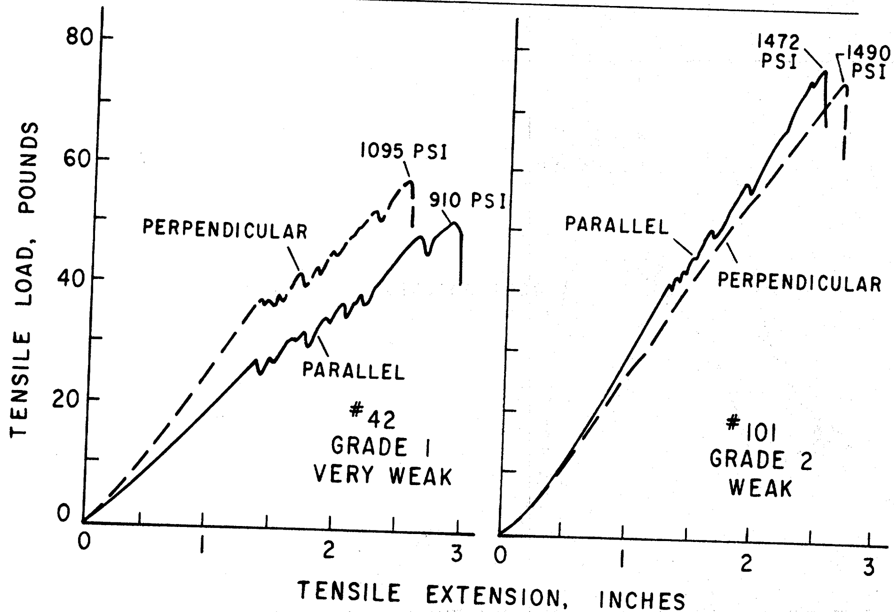

FIGURE 3.—Tracings from tensile tests on specimens representative of the two degrees (grades) of weak leather. Grade 1 (defective) shows very low breaking strength, early and frequent cracking, and much extensibility. Grade 2 represents an intermediate structure that is not definitely defective but does cause abnormal weakness.

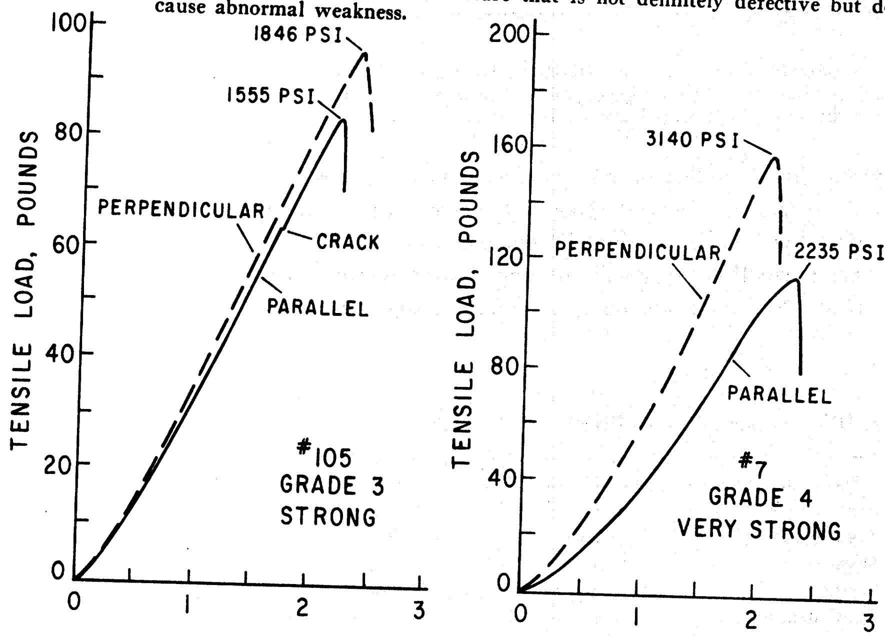

FIGURE 4.—Tracings from tensile tests on specimens typical of the two grades of strong leather. The vertical scale is doubled on the right. Compare with Figure 3 to see pronounced difference in cracking behavior.

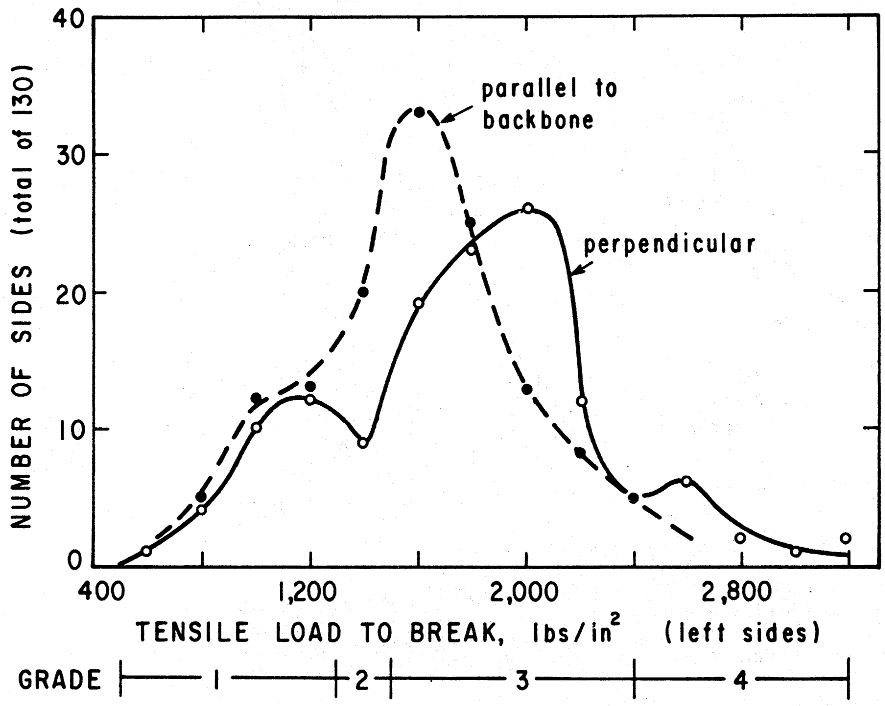

FIGURE 5.—Distribution of tensile load values from 130 Hereford sides. The curve for the perpendicular specimens gives good discrimination, as defined for Figure 1, while that for the parallel direction does not.

Using the arbitrary grade limits indicated on the distribution curves, the 130 hides were classified as shown in Table I. About 18 percent of the hides were extremely weak or defective, while another 12 percent were moderately weak; about 62 percent were normally strong and the remaining few were very strong. As for the extent of agreement among the distinguishing properties,

TABLE I

HIDE CLASSIFICATION BY LEATHER STRENGTH

Grade*	Strength	No. Hides	Percent
1	Very weak	23	17.7
2	Weak	16	12.3
3	Strong	80	61.5
4	Very strong	11	8.5
		130	100.0

*Arbitrary designations indicated from peaks in distribution curves (see Figures 1, 2, 5).

75 percent of the hides agreed in at least four out of five; 95 percent of them agreed in at least three out of five. It must be emphasized that this classification was relative and not absolute; it picked out the weakest and strongest leathers within a fairly comparable group. Separate limits for weak and strong must probably be determined for each given type of leather.

Strength Correlations

Correlation with Fiber Structure.—Color slides of the sharply cut edges of leather strips, when projected on a screen, gave considerable information on the internal structure. Although resolution and detail were not as good as could be obtained with the microscope, this did permit evaluation of a large number of samples in a relatively short time. The main structural features related to strength are the angle of weave, extent of interweaving, and compactness. Apparent porosity or looseness from the flesh side is a good index of these features. Therefore, the depth of dye penetration is usually a helpful guide.

Figure 6 shows the contrast between the Grade 1 and 2 weak samples and the Grade 3 and 4 strong samples. In the weak strips (Figures 6a and 6b) notice that the fibers are nearly vertical and loosely arranged with very little interweaving. The brown dye, when viewed in color, has penetrated almost the entire corium. In the strong strips (Figures 6c and 6d) the fibers are interwoven and compact, with a much lower weave angle. Here the dye has penetrated only the lower portion of the corium, leaving a good chrome-colored zone in the center. It was found that the best way to evaluate the samples was to estimate the proportion of corium showing loose structure by the criteria mentioned. In this case the top sample of Figure 6 was rated about 100 percent and the bottom one about 30 percent.

In Table II the results of photographic grading of the structure of the 130 hides are summarized by arranging them according to their classification into four grades of strength. Good correlation between structure and strength is evident. As a general rule, adequate strength could be accurately predicted from samples showing no more than 50 percent of the corium affected. Defective samples usually showed at least 80 percent looseness.

Correlation with Composition.—As mentioned previously, fat liquor is known to penetrate more deeply into "pulpy" leathers because of their loose structure. It was of interest to determine analytically the extent of correlation between the four strength grades and the fats and various other additives that might be present. Table III shows the average values obtained from six specimens of each grade, with separate averages for weak *versus* strong groups. Weak leathers absorbed 7.3 percent fat compared with 6.8 percent for the strong. Ash values showed a continuous gradient ranging from 8.5 percent for very weak to 7.1 percent for very strong, reflecting the increasing compactness of structure. As ex-

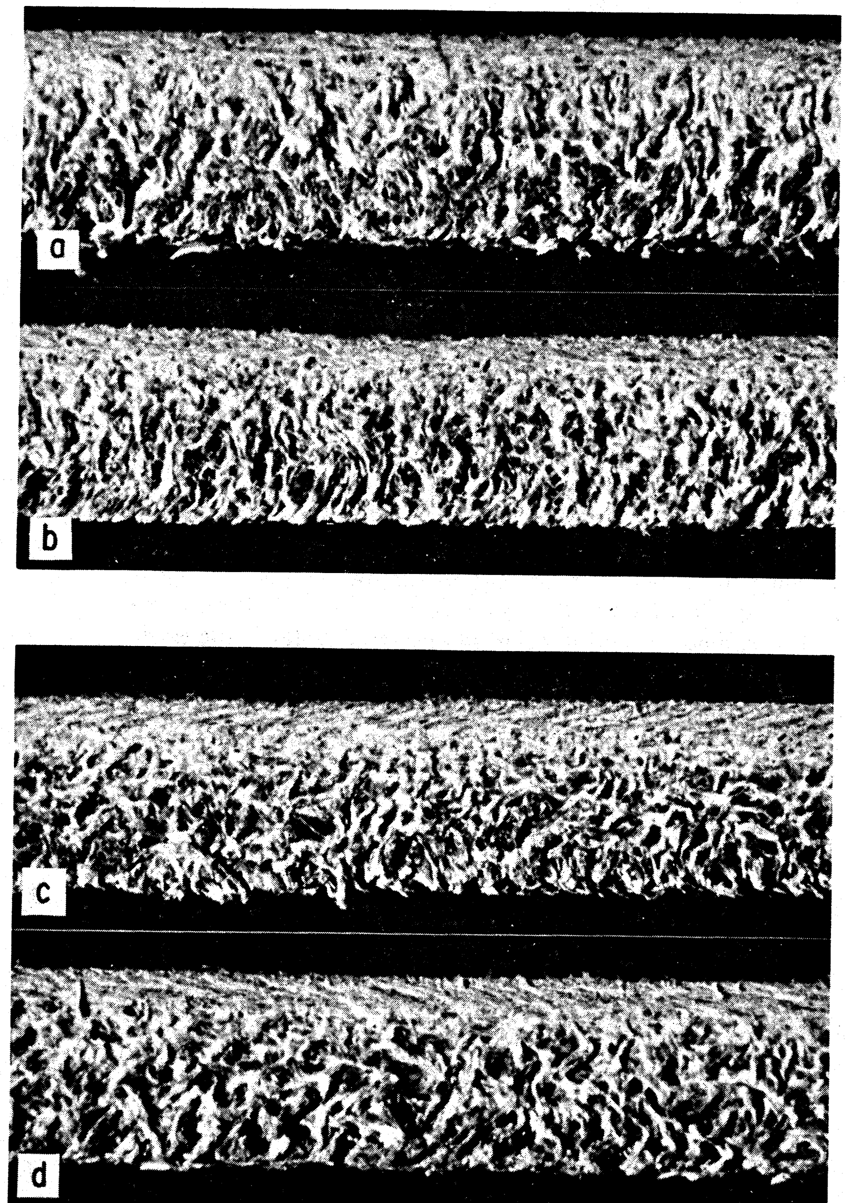

FIGURE 6.—Close-up views of freshly cut edges of leather strips typical of each of the four strength grades illustrating the corresponding structures: (a) Grade 1; (b) Grade 2; (c) Grade 3; (d) Grade 4. Although not apparent here, dye has penetrated from the flesh side almost the entire thickness in the weak leathers (a and b), obscuring the chrome color; in the strong leathers (c and d) the dye has penetrated less than halfway, leaving a chrome-colored streak in the middle.

TABLE II

CORRELATION OF FIBER STRUCTURE WITH STRENGTH

Corium* Looseness (percent)	Number of Hides in Each Strength Grade†			
	Grade 1	Grade 2	Grade 3	Grade 4
100	5	0	0	0
90	6	0	0	0
80	9	4	0	0
70	3	7	3	0
60	0	4	28	0
50	0	1	40	2
40	0	0	9	4
30	0	0	0	5

*Criteria for evaluation from close-up photographs are defined in the text.
†See Table I.

pected, chrome content did not vary significantly. However, silica, from a silicone treatment added for water repellency, also varied in the same manner as total ash. Likewise the balance of the ash, perhaps mostly lime, also showed a gradient ranging from 1.9 percent to 1.0 percent. This information confirms structural observations with respect to compactness but does not represent a very wide range of variability.

Correlation with Genetic Origin.—The principal objective of this study was to determine the relative incidence of leather weakness among the hides obtained

TABLE III

CORRELATION OF CHEMICAL COMPOSITION WITH LEATHER STRENGTH

Grade	Strength	Percentage Composition*			
		Fat** (MAFB†)	Ash (MFB‡)	Chrome (MFB)	Silica (MFB)
1	Very weak	7.18	8.47	4.69	1.84
2	Weak	7.37	7.96	4.75	1.73
3	Strong	6.74	7.48	4.87	1.41
4	Very strong	6.84	7.05	4.85	1.21
Average Weak		7.28	8.22	4.72	1.79
Average Strong		6.79	7.27	4.86	1.31

*Average for six samples of each grade determined in duplicate, except for the silica determination, where pooled samples were used.

**Sum of chloroform and ether extracts, the latter ranging from 0.1 to 0.2 percent.

†Calculated on a moisture- and ash-free basis.

‡Calculated on a moisture-free basis.

from the offspring of a number of sire bulls. Concentration of the defect in a few families would suggest a common type of genetic control. Figure 7 shows the incidence of each of the four strength grades in the progeny of the 15 sires of this group. Considerable variation is evident. Some families show much weakness and some show none; eight of the 15 had a frequency of greater than 35 percent when Grades 1 and 2 are combined. Bulls K and M exceeded 60 percent but both had small numbers of offspring in the group. Bulls A, D, E, and G accounted for most of the defective hides.

Maternal grandsires were known in 52 cases. When their grandsons were arranged into family groups, the incidence of weakness followed a similar pattern of frequently high levels. One bull (C) was father of 11 subject steers and grandfather of seven others. His total record was 33 percent weakness with 11 percent very weak. Another bull had 19 grandsons in the group, and 32 percent of them had weak hides with 26 percent very weak. Two bulls were father and son, each with nine grandsons in the group. Their combined record was 33 percent weakness. It is thus apparent that many of the bulls in this study showed a strong tendency to sire offspring with abnormally weak hides.

It was interesting to note that three of the experimental hides had black hair. Leather data from these were excluded from the 130 finally evaluated, along with several others showing wide disagreement between left and right sides. The black-haired steers were known to have Hereford mothers and were prob-

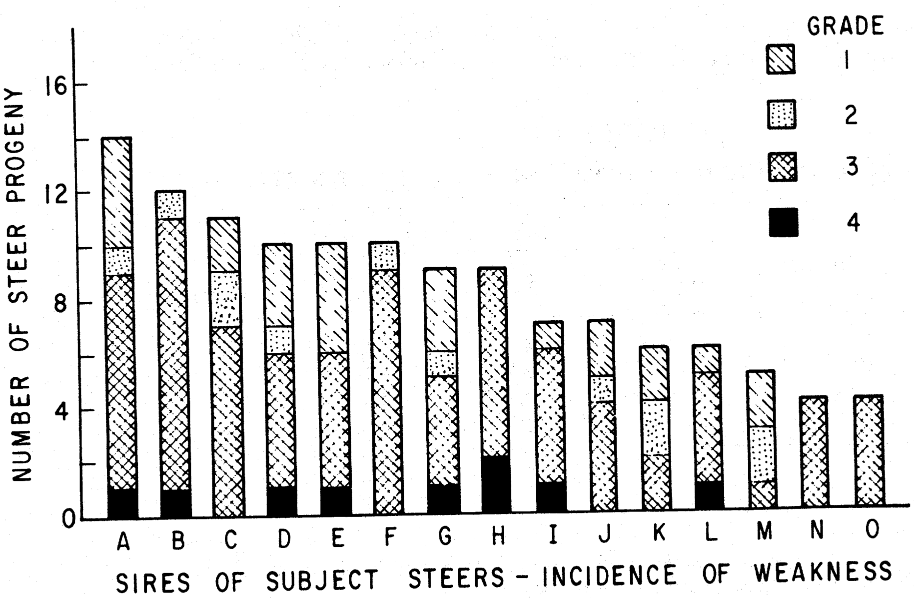

FIGURE 7.—Incidence of each of four strength grades in leather from the hides of the steer progeny of 15 Hereford bulls. Grade 1 is very weak and defective; Grade 2 is weak; Grade 3 is normally strong; Grade 4 is very strong.

ably Angus-Hereford crossbreeds. Although these particular hides were strong, it seems possible that reported cases of defective Angus hides were actually from such crosses, and the defect may have been transmitted genetically.

Unfortunately, this series was not large enough to provide highly significant evidence on the question of heritability. Owing to the prevailing practice of maintaining sire records only, it would probably require about a threefold expansion of this group to reach a satisfactory level of confidence. Attempts to locate additional progeny from the same bulls were unsuccessful.

CONCLUSIONS

Within a given line of leather, and with specimens from a standard location, a new scheme for classifying Hereford sides into four strength grades has been achieved. The weakest of these grades was consistently characterized by the presence of the vertical fiber defect.

Whether this defect is uniquely linked to the Hereford breed, and perhaps occurs in black-haired hides from crossbreeds, seems possible but remains unknown. Present evidence suggests that it is genetically transmitted among Herefords, but evaluation of larger numbers of offspring would be required to establish with certainty the mechanism involved.

A practical application is suggested from the photographic grading of fiber structure in a leather cut. It was found that a stereoscopic microscope, at low magnification, was equally satisfactory and, in turn, could be replaced with a good hand lens. When dyed crust stock from the proper location is thus examined, a wide chrome streak and well interwoven fibers indicate strong leather with considerable confidence.

ACKNOWLEDGMENTS

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REFERENCES

1. Amos, G. L. *J. Soc. Leather Trades' Chem.*, **42**, 79 (1958).
2. Tancous, J. J. *JALCA*, **61**, 4 (1966).
3. Tancous, J. J., Schmitt, R., and Windus, W. *JALCA*, **62**, 4 (1967).
4. Tancous, J. J., Schmitt, R., and Windus, W. *JALCA*, **62**, 781 (1967).
5. Everett, A. L., Willard, H. J., and Windus, W. *JALCA*, **62**, 25 (1967).
6. Maeser, M. *JALCA*, **63**, 570 (1968).
7. Reid, J. A., and Maeser, M. *JALCA*, **62**, 468 (1967).
8. Maeser, M. *JALCA*, **64**, 328 (1969).
9. Montagut, M., Obiols, J., and Genis, I. *Boll. Tech. Assoc. Quim. Espan. Ind. Cuero*, **19**, 309 (1968); *Chem. Abstr.*, **71**, 40243d (1969).
10. Dellamonica, E. S., and McDowell, P. *JALCA*, **66**, 21 (1971).

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DISCUSSION

DR. NAGHSKI: Thank you very much, Al. The paper will be discussed by Mieth Maeser. . . Slim.

MR. MAESER: We've been asked by the Chairman of the convention to try to put the material of the various papers in the perspective of their future value. Going over a paper like this, it seems to me that if the developments which Mr. Abel projected this morning really are realized in the next few years, or even — much more to the immediate point — if the number and size of shoe factories that are using semi-automatic or slightly less than semi-automatic shoe processing systems increase in size and number at the rate that they have been for the past few years, and if — a third thing — the proposition that Dr. Tu was talking about becomes real and developed, so that our synthetic materials are more desirable as shoe materials than they are today, we're going to find that leather, as it is now supplied to the shoe manufacturers, will become less favored.

Let me clear this up.

I do not mean that leather will become less favored as the shoe material, but that it will become far less favored as a shoemaking material than it is today.

A fair number of our very large production shoe factories are using no leather at all today, mainly because of the fact that every shipment of leather that goes to those factories contains three to ten or more percent of leather that is defective in some way, so that it will not go through automatic processes without some failure.

Such leather gets cut and worked on in several operations, only to find that lasting, or some other operation way down towards the end, spoils it. The shoe is ruined. The work is lost. The system is upset.

The leather industry can do nothing about these three "if's." Their future will be controlled by other industries.

But there is the problem of finding a solution to this weak leather. This defective leather problem is the leather industries' problem and it rests right on their shoulders. Nobody can help them with it! So a paper such as this gives us one more angle to look at in trying to find some means that will aid us in eliminating this inferior defective leather from the shipments that you are sending to the shoe industry.

Now to speak a little more directly to this paper, Mr. Everett showed two distribution curves, one of which was the lasting factor calculated from data obtained in the one-inch Ball Burst Test on specimens cut from the lower rear section of the official sampling area.

For other purposes my company tested a very large number of hides, or sides, which were made into the same kind of leather, cut at the same location, and tested with the one-inch Ball Burst Test.

I calculated the same lasting factor for this much larger sample. (May I have the slide, please?) In this random large sample, we have a perfectly normal, slightly biassed distribution of the data. The heavy line is Mr. Everett's curve, plotted point-to-point rather than as a smooth curve. You see that in his sample, which was pitched with a deliberate bias in it, we do not get the same curve that we get from a random selection of this leather.

I think this very fact that there is such a difference in the distribution adds considerable weight to his conclusion that there are very prominent genetic influences.

MRS. TANCOUS (Tanners' Council Laboratory): Do you know which bulls and which cows are involved with this faulty leather? Could these be disposed of?

MR. EVERETT: Not as long as they make good beef.

MRS. TANCOUS: I mean, the advantage of having a study like this would be that we could get rid of these problems.

VOICE: That's wishful thinking, I'm afraid. It's more or less academic, in other words, to find out that it is genetic.

DR. CONSTANTIN (Pfister and Vogel): Al, maybe the question should be more properly directed to Joe Naghski. I presume this was one of those herd improvement studies, this genetic study, and what was the point of the study? I'm almost afraid to ask the question because I think it was feed conversion ratios or something like this.

DR. NAGHSKI: You're right. These animals were from the feed performance studies, and of course they were only interested in feed conversion and meat cuttability and things like that, but we thought this was an excellent opportunity to get hold of some material that we knew something about the genetic history of and see if we could establish a relationship.

I am not quite as pessimistic as Al. I think if we ever get it established, we probably could do something about it.

DR. CONSTANTIN: Joe, the next question, obviously is: Were these poor hides unfortunately from sires that gave good feed conversion performances, as I suspect they'd have to be?

DR. NAGHSKI: We don't know that for sure, but we did learn that most of these sires were rejected, so I think we might be working in the right direction.

DR. CONSTANTIN: Al, one other question, please. If I remember, you did your physical tests at a point six inches from the tail and 12 inches in from the backbone, which is the lower lefthand corner of the A-area. Why did you pick this particular point, in contrast to, let's say, eight inches from the tail and four inches down from the backbone which, I think, in most of our experience would give us the worst possible results? In other words, you are outside the area where you see the worst physical test results, in our experience, from this vertical fiber bundle of beef cattle.

MR. MAESER: May I answer that?

DR. NAGHSKI: Yes, please do, Slim.

MR. MAESER: I took a number of hides and determined the Ball Burst Test properties all over those hides, and the worst area that I found in *pulpy* hides was still further from the butt than eight inches and still further than 12 inches from the backbone. That was the worst section.

However, also in that paper, I think I established very clearly that, if pulpiness exists at all, the effect is carried over a fairly large section of the butt and bend section of the hide, and that samples cut from any uniform position in that area will be relative to one another . . . about the same, as if they were all cut from the worst possible area. So we'll pick them up in any case.

VOICE: At the present time, we're screening fairly large numbers of sides coming through the tannery for experimental purposes. Our procedure at the moment is to check the point two inches in from the backbone and about eight or ten inches from the tail. If we find a failure there, or if we find a weak reading there, we take three in a circumference two inches outside of that and then continue on until we find a point where we no longer have a failure. In our experience, 80 percent of the time, once we trimmed the second circle, we're outside of this area of the influence of pulpy butt, but we would still be well inside this 12-inch point.

MR. MAESER: Well, there's a very sharp change in the physical strength of leather in this location. The butt is quite strong but about a foot away the hide is very weak.

If you carefully cut right down the center of the backbone, one of the weakest spots in the whole hide is adjacent to the backbone about 12 inches in from the tail, and then you get a very sharp rise in strength until you have gone in, depending on the size of the hide, for six or eight inches, and then you get another drop-off into what is, most typically, the pulpy area.

The main reason we took these in the position we did is that this is the sampling area and I kept within the sampling area as close as possible.

DR. SELIGSBERGER (U. S. Army Natick Laboratories): Why were these all killed at the same age, approximately, and when you say "steer" are you excluding heifers from the lot?

MR. EVERETT: I'm not sure we know the ages of these. I would think they'd be very closely similar. We know their market weight — 950 to 1050 pounds — and they're all steers.

DR. NAGHSKI: Well, gentlemen, thank you very much and thank you all for a nice discussion.